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(54) Self-monitoring flow control valve

(57) A valve which may be used to monitor its own performance and generate control or data signals accordingly, has a valve chamber 1, a valve member 5 movable within the chamber 1, means 6,7 for moving the valve member 5 between operative positions and including sensing devices 16,18,19, such as position, temperature and pressure sensors, and a micro-processor 14 mounted in or on the valve and connected to the sensing devices 16,18,19. The micro-processor is programmed to monitor the performance of the valve on the basis of the input data provided by the sensing devices and provide performance data and/or warning signals and/or control signals on the basis of the input and calculated data. Sensing devices may also be provided for sensing other process parameters and feeding the data to the micro-processor 14. The micro-processor 14 may also be programmed to apply control measures to the operation of the valve, and to display the fact that it had done so, in the event of particular sensed or calculated parameters falling outside a predetermined range.

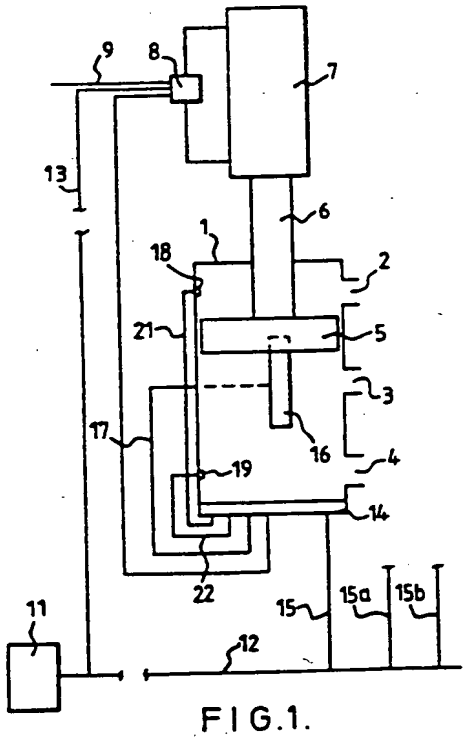

FIG.1.

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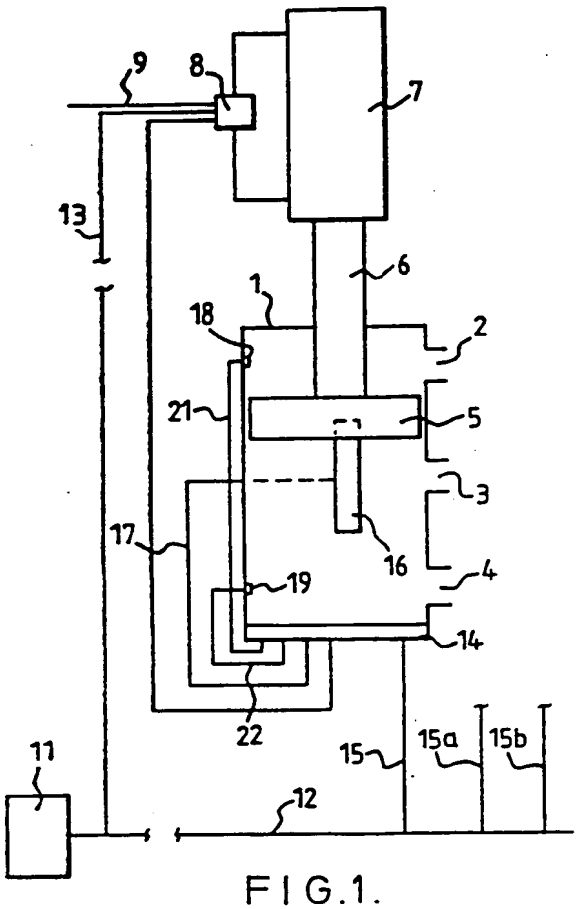

FIG.1.

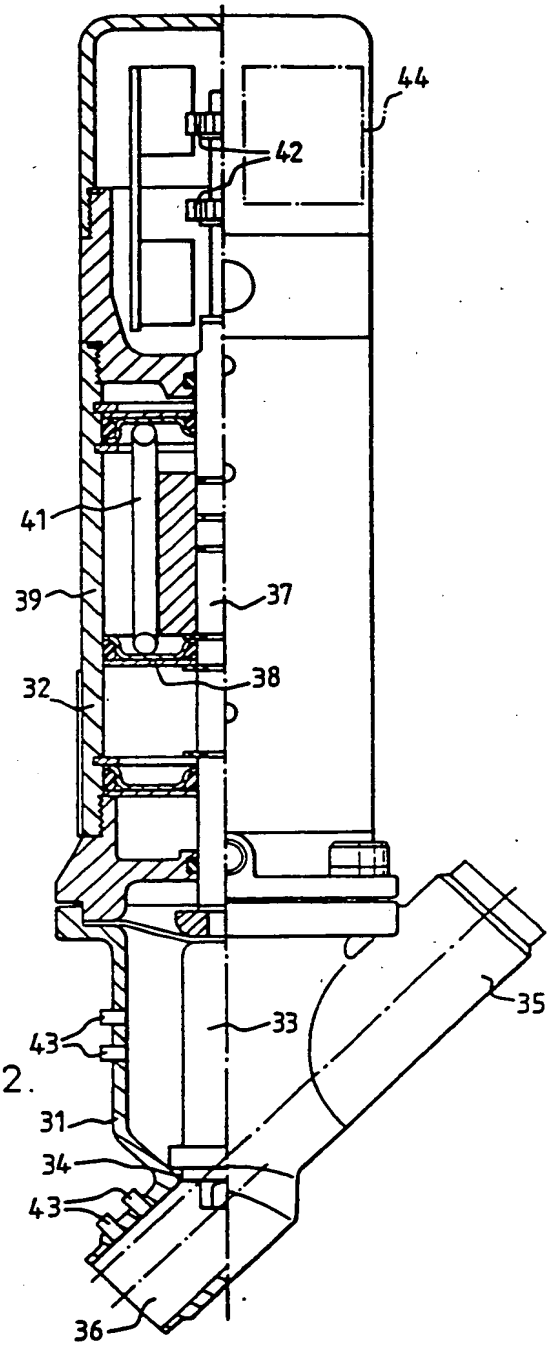

FIG.2.

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SPECIFICATION

Flow control valve

This invention relates to flow control valves.

Flow control valves are widely used, singly or in groups, as part of plant for the processing of fluids.

It is known to monitor and control the operation of plant, including valves, by means of a central control computer, such as a mini- or micro-computer. For this purpose, the individual pieces of apparatus comprising the plant are each provided with sensors and probes connected to the remote computer and arranged to supply data via suitable highways. The plant, which may include heat exchangers and other processing equipment, is controlled by valves and other control gear which are remotely operated and controlled by means of signals generated either manually or by the computer and transmitted either along the same highways or along dedicated cables.

It is an object of the invention to provide a valve which may be used to monitor its own performance and generate control or data signals accordingly.

In accordance with a first aspect of the invention, there is provided a flow control valve comprising a valve chamber, a valve member movable within the chamber, means for moving the valve member between operative positions and including sensing devices and a micro-processor mounted in or on the valve, preferably on a control head for the valve, and connected to the sensing devices and programmed to monitor the performance of the valve on the basis of the input data provided by them and provide performance data and/or warning signals and/or control signals on the basis of the input data.

The inclusion of a micro-processor (or chip) as an integral part of the valve would permit a proportional, integral and derivative (PID) control loop capability, with a serial link, eg by a cable, to other external control and monitoring facilities. The valves of a plant could all be connected via their serial links and a simple wiring network to the central control computer.

Access to the PID function would normally be only available to specialist personnel, such as commissioning engineers.

The software should be capable of averaging the last achieved operating position of the valve, and would thus provide an update for the valve positioner. In this way, the valve becomes effectively self tuning.

When used with a multi-position valve, the use of a microprocessor allows set point positioning of the valve for various flow conditions and for automatic adjustment of their positions.

It is preferred to use flying leads from the sure and possibly other parameters for the local (PID) control loop and comparison with datum levels. The datum levels in the software could be adjusted via the serial link.

In an on/off valve, the micro-processor and its software could incorporate the function of limit switches to monitor and control the on/off operation. Such valves could also incorporate the temperature and pressure sensors, which would not necessarily involve a control function on the valve itself, but which would be connected to the central control computer by the serial link.

Also, where a group of valves, particularly on/off valves, are used for a more complex function, eg as a four valve steam barrier, the micro-processor could monitor and control the correct inter-relation of the valve functioning.

Sensing devices may also be provided for sensing other process parameters and feeding the data to the micro-processor.

The micro-processor may also be programmed to apply control measures to the operation of the valve, and to display the fact that it had done so, in the event that particular sensed or calculated parameters fall outside a predetermined range, eg if the valve did not complete its design travel or if the sensed pressure (or an unwanted rapid change therein) indicates a valve or seal failure.

The inventon will be further described with reference to the accompanying drawings, in which:

Figure 1 is a diagrammatic showing of salient features of a valve in accordance with one form of the invention and associated controls; and

Figure 2 shows the arrangement of parts on a particular form of valve.

Figure 1 shows diagrammatically a flow control valve including a valve chamber 1 having three ports 2, 3 and 4, communication between which is controlled by a valve member 5 connected to a piston rod 6 of a single- or double-acting pneumatic cylinder 7.

A control valve 8 for the compressed air supply 9 to the cylinder is also shown.

It will be appreciated that the flow control valve is part of a more or less complex plant, and a central control computer is indicated by a block 11. A highway 12 carries data and control signals to and from the computer 11, and in particular a line 13 connects it to the valve 8.

As so far described, the illustrated structure is typical of contemporary practice in the process engineering industry.

In accordance with the invention, the valve has mounted therein or thereon a micro-processor 14 connected by a serial link 15 to the highway 12. Figure 1 shows the micro-processor 14 mounted on the valve chamber 1, but in practice, as shown in figure 2, other locations are more likely. Figure 1 shows the valve chamber 1 as including a sensing means

16, in the form of an elongate sensor or array of sensors, to detect the position of the valve member 5 in the valve chamber 1, and to pass information via a line 17 to the micro-processor 14, which also receives input data on local temperature and pressure conditions in the valve chamber 1 from sensors 18 and 19 via lines 21 and 22 respectively.

A further line 23 is shown as connecting the micro-processor 14 with the valve 8 to receive data as to the state thereof and also to provide a control signal signal thereto as appropriate.

The lines 15a and 15b illustrated are analogous to the serial link 15 and connect the highway to other flow control valves (not shown).

In a practical form of valve in accordance with the invention, substantial information will need to be stored in the microprocessor 14 for performance correlation.

For example, if the desired position values are stored in the memory, the deviation from the desired position can be calculated and displayed, and the values reset if required.

If individual pressures are measured, then a warning can be incorporated against exceeding the design pressure of the apparatus. Also, a loss of pressure may be used to detect and locate failure of a seal or valve, and possibly to take corrective isolating action to limit or contain damage.

From the temperature measurements, a warning could be issued of any temperature excursion beyond the design value.

Such pressure and temperature excursions could be stored in memory.

Turning now to figure 2, this shows, partly in section and partly in elevation, a practical form of valve with a straight through configuration, although it will be understood that a similar valve may be used for other configurations, such as 90° or T configurations.

The valve has a valve chamber 31 attached to an operating cylinder 32. Within the valve chamber 31 is a valve head 33 having a seal 34 co-operating with a seat in the valve chamber 31 to control flow through the valve chamber between connections 35 and 36. An operating shaft 37 carries a piston 38 operable in a pneumatic cylinder 39, and a spring 41 urges the valve head into the fail-safe closed position illustrated.

The shaft 37 extends beyond the cylinder 39 into a control head 40, where it has markers 42 by which its position may be automatically detected, using suitable sensors, possibly microswitches. Reference numeral 43 indicates the positions of ports in the valve chamber 31 for accommodating sensors for operating parameters, such as temperature, pressure and flow rate.

The information derived from these sensors, and those sensing the position of the shaft 37, and consequently the head 33, is fed to a micro-chip system (micro-processor 14), which is housed as indicated at 44 in figure 2 in the control head 40. This micro-chip system 44 is programmed to provide any or all of the following functions:

(a) local intelligence linking several process related valves;

(b) valve position feedback;

(c) direct analogue control (PID)

(d) network linking to other process related microchip systems;

(e) transmission of sensor parameters; and

(f) serial link.

Various other modifications may be made within the scope of the invention.

CLAIMS

1. A flow control valve comprising a valve chamber, a valve member movable within the chamber, means for moving the valve member between operative positions and including sensing devices and a micro-processor mounted in or on the valve and connected to the sensing devices and programmed to monitor the performance of the valve on the basis of the input data provided by them and provide performance data and/or warning signals and/or control signals on the basis of the input data.

2. A valve as claimed in claim 1, in which the sensing devices include a position sensor for monitoring the position of the valve member.

3. A valve as claimed in claim 1 or 2, in which the sensing devices include temperature and pressure sensors.

4. A valve as claimed in any of claims 1 to 3, in which the micro-processor is programmed to apply control measures to the operation of the valve, and to display the fact that it had done so, in the event that particular parameters fall outside a predetermined range.

5. A valve as claimed in any of the preceding claims, in which the micro-processor is mounted on a control head for the valve.

6. A flow control valve substantially as hereinbefore described with reference to the accompanying drawings.

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